April 23, 1857.

The LORD WROTTESLEY, President, in the Chair.

The following communication was read:—

" On the Magnetic Induction of Crystals." By Professor Julius
Plücker, of Bonn, For. Memb. R.S., Hon. M.R.I., &c.
Received March 26, 1857.

[Abstract.]

The author commences by referring to his discovery of the peculiar
action of magnets on crystalline bodies, and to the researches to
which he was thereby led. With reference to the form in which he
enunciated the law regulating the action of a magnet on a uniaxal
crystal—that the optic axis is attracted or repelled by the poles of
the magnet—he disclaims any intention of assigning a physical cause
to the phenomenon, or doing anything more than expressing the
results of observation, which are *as if* such a force existed. In the
case of crystals of a more complicated character, he was led, in the
first instance, to assume the existence of two magnetic axes, possessing
a similar character as to attraction and repulsion with the one axis of
optically uniaxal crystals. But finding that the proposed law did
not hold when the crystal was examined in all directions, and not
solely along peculiar axes, he abandoned, nearly two years ago, a
hypothesis respecting which serious doubts had arisen long before.
For the hypothesis of one or two axes acted upon by the magnet,
he substituted another similar hypothesis. In the case of uniaxal
crystals he now conceived an ellipsoid of revolution, consisting of
an amorphous paramagnetic or diamagnetic substance, and having
within the crystal its principal axis coincident with the principal
crystallographic axis. It is easy to verify that both crystal and
ellipsoid, the poles of the magnet not being too near each other,

will be directed between them in exactly the same way. In the generalization, an ellipsoid with three unequal axes, having a determinate direction in the crystal, must be substituted for the ellipsoid of revolution. In this hypothesis too, two "magnetic axes" are met with, that is, according to the new definition, directions which possess, in common with the single crystallographic axis of uniaxal crystals, the property that if the crystal be suspended so that either of these axes is vertical, and the body is at liberty to turn freely round it, no extraordinary magnetic action is exhibited, but the crystal behaves like an amorphous substance.

According to observation, a crystal under favourable circumstances is directed in the same way as the smallest of its fragments. Hence, according to the new hypothesis, each of its particles may be regarded as acted on like an amorphous ellipsoid. But such an amorphous molecular ellipsoid, when influenced by a magnetic pole at a finite distance, will be directed like an ellipsoid of finite dimensions under the influence of an infinitely distant pole. Here Poisson's theory presented itself for the verification of the hypothetical conclusions and their consequences, to which the author had been led by considerations of a different kind. This verification had the most complete success. But before proceeding to it, it was found necessary to confirm Poisson's theory itself (or rather the results following from it), with respect to an ellipsoid of finite dimensions influenced by an infinitely distant pole. By means of a beautiful theorem lately published by Professor Beer, by which the results relating to the influenced ellipsoid are simply and elegantly expressed by means of an auxiliary ellipsoid, the author was enabled to deduce immediately the analytical expressions. These were afterwards compared with experiment, by observations made on two carefully worked ellipsoids of soft iron, executed by M. Fessel of Cologne.

The results thus obtained from theory, and verified by experiment, with reference to an amorphous ellipsoid, were compared with the results obtained from the observation of crystals, and manifested a complete agreement. According to this theory, the magnetic induction within a crystal is, like the elasticity of the luminiferous ether, determined by means of an auxiliary ellipsoid. As there are three rectangular axes of optical elasticity, so there are three principal axes of magnetic induction, characterized by the property that if a

crystal be suspended along any one of them, the two others set, one axially, and the other equatorially. As there are two optic axes, situated in the plane of the axes of greatest and least elasticity, so there are two magnetic axes, characterized by the property already mentioned.

Among crystals, the author selected for special examination red ferrocyanide of iron, sulphate of zinc, and formicate of copper. The first is paramagnetic, the second diamagnetic, and in both cases the principal axes of magnetic induction are determined by the planes of crystalline symmetry. The setting of elongated prisms, as well as of long cylinders and short cylinders or circular plates, cut in various selected directions from the crystals, is described in detail. The use of both cylinders and circular plates, cut with their axes in the same direction, obviated any objection which might be raised attributing the setting to the external form, since, so far as was due to mere form, a cylinder and a circular plate would set with their axes in rectangular directions.

Formicate of copper differs from the former crystals in having but one plane of crystalline symmetry, and accordingly in having but one principal axis of magnetic induction determined by the crystalline form. The existence of three principal magnetic axes, having the property already mentioned, was demonstrated experimentally, and the directions of those two which were not determined by the crystalline form, were ascertained by experiment. In this crystal the axes of greatest and least induction, and consequently the magnetic axes, lie in the plane of symmetry; and the existence of two magnetic axes was demonstrated, and their positions were determined.

In conclusion, the author gives a list of crystals, classified according to their paramagnetic or diamagnetic characters, and the order of magnitude of the magnetic inductions in the direction of their principal axes. He also remarks that some crystals, of which instances are given, though belonging according to their form to the biaxal class, have two of their principal magnetic inductions so nearly equal that they cannot be distinguished from magnetically uniaxal crystals; while others, though not belonging to the tesseral system, have all their principal inductions so nearly equal that they cannot be distinguished from amorphous substances.